

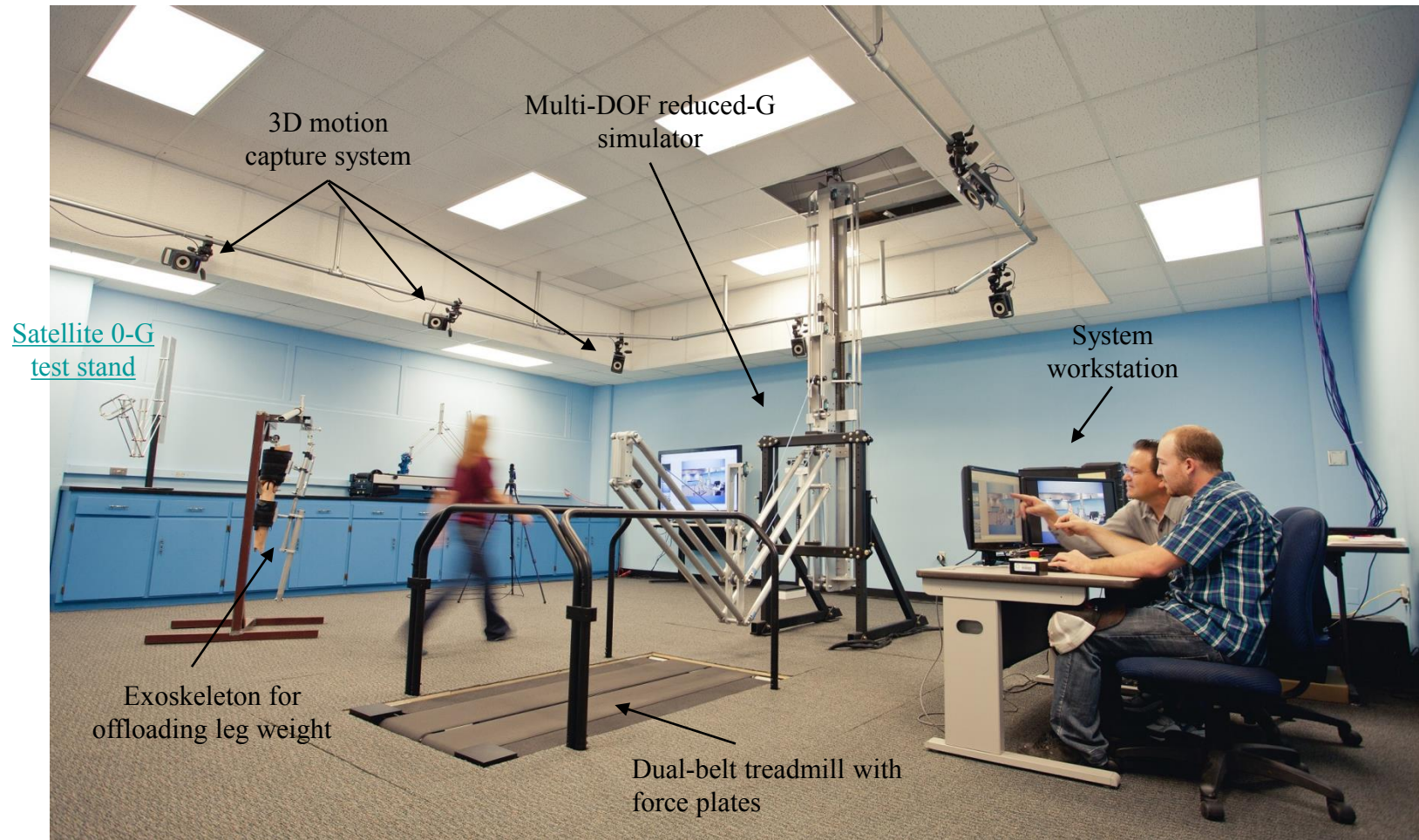
Reduced-Gravity and Biomechanics (RGB) Laboratory and Robotics and UAV Laboratory

Ou Ma

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RGB videos demos available at: <http://www.youtube.com/channel/UCZ1EFux2g75RPy6a9kR-2zw>

Reduced-Gravity and Biomechanics (RGB) Laboratory



Lab manager: Kenneth Ruble (Tel: 575-646-5532)

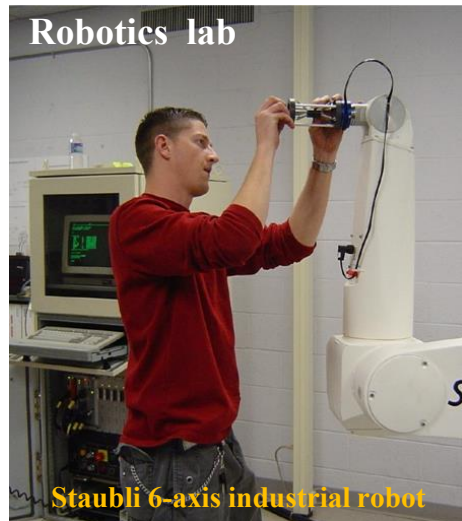
Robotics, Mechatronics and UAV Laboratory



UAV lab

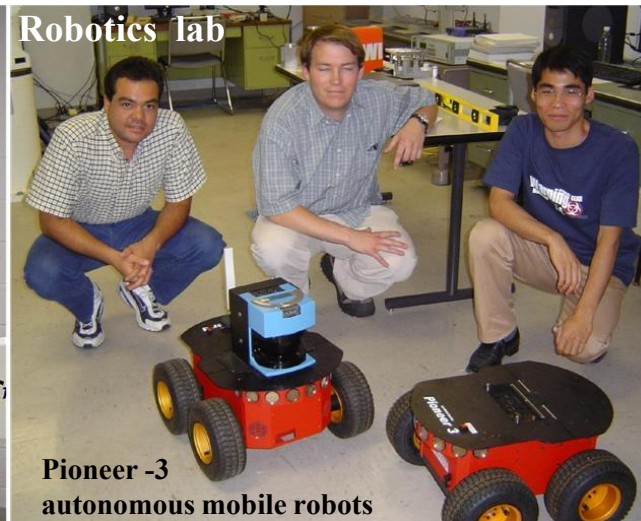


Yamaha RMAX II helicopter



Robotics lab

Staubli 6-axis industrial robot



Robotics lab

Pioneer -3
autonomous mobile robots

[Video1](#)

[Video2](#)

Education and Outreach Efforts



Undergraduate students Alexandra Mauer and Ember Krech assembling AFRL satellite test stand



Undergraduates students, Jason Wright, Tom Nicklaus, Steven Stroup and Rachel Tessier assembling the simulator.

Students trained in the last 5 years:

- 11 Ph.D. students
- 11 M.S. students
- 32 Undergraduates (excluding capstone teams)
- 12 Community college students (AMP)
- 13 High school students (EXCEL)

Outreach activities in the past 3 years:

- 1655 Students toured the RGB lab
- 106 Professionals toured the RGB lab
- Students made many presentations and workshops in other schools and public events



Student team performing flight testing of an autonomous UAV



Undergraduate students Jeremy Bruggmann and Jacob Gilbert testing a robotics-based satellite inertia identification algorithm in microgravity flight onboard NASA's C-9 aircraft



Undergraduate students Gabriela Anguiano-Molina and Brandon Mee testing the RGB system

Research Activities

- Study of human performance and factors in zero- or reduced-gravity environments (e.g., Moon, Mars, an asteroid or orbit)
- Development of technology for predicting fall risk of older adults
- Development of technology for mathematical modeling and simulation of human body dynamics
- Bio-inspired UAV design, modeling, guidance and control
- Space robotics control and ground-based simulation and experiment
- Impact-contact dynamics modeling and experimental study

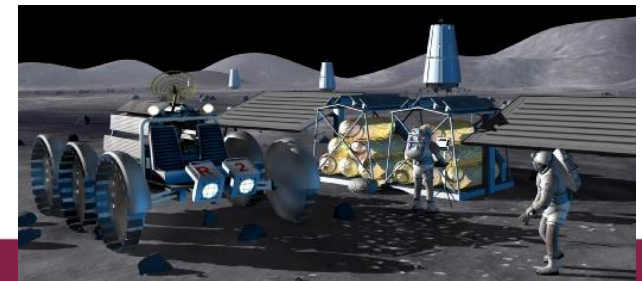
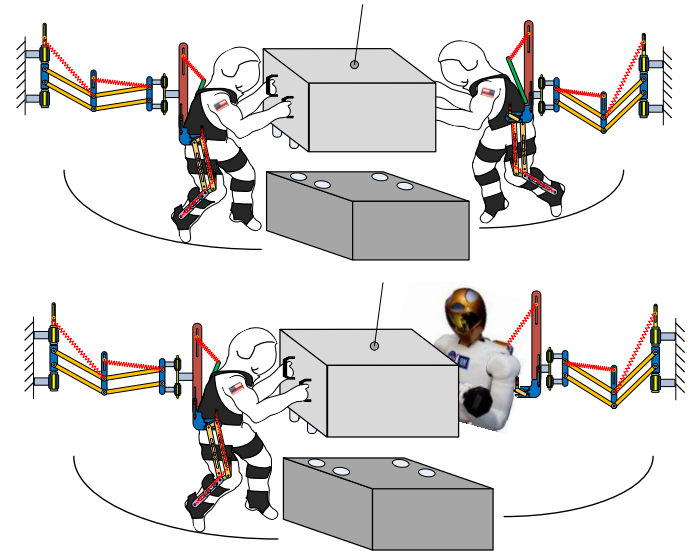
Output: In last 5 years, Dr. Ma and his students have published 17 peer-reviewed journal papers and 41 conference papers, and received 2 US patents.

Outlines of these projects are in the next few slides

Study of Human Performance and Factors in Zero- or Reduced-Gravity Environment



Study human-human or human-robot interactions for EVA tasks in future space missions.



Key collaborating researchers:

Dr. Ou Ma, Mechanical and Aerospace Engineering Department
Dr. Robert Paz, Electrical and Computer Engineering Department
Dr. Edward Pines, Industrial Engineering Department
Ken Ruble, Mechanical and Aerospace Engineering Department

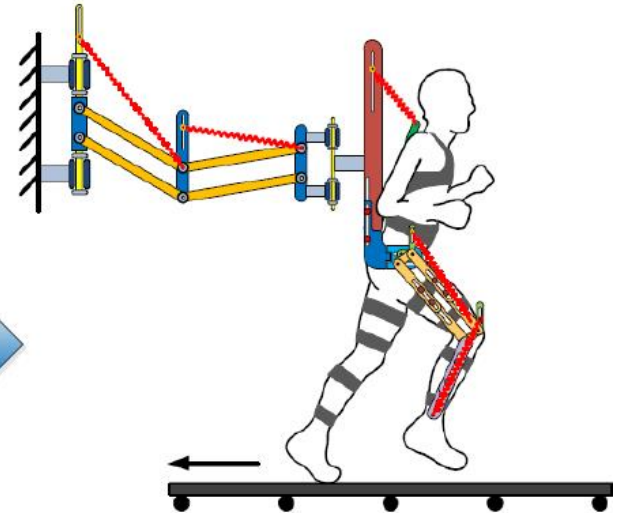
Technology to Assist Mobility Rehabilitation

Current body weight support & offloading methods



Currently available active or passive body weight support (BWS) devices

Our new body weight support & offloading method



Improvements:

- Multiple degrees of freedom and passive in operation
- Offloads weight of the entire body including legs
- Adapts to individuals with different sizes and weights
- Leg exoskeletons offload weight only when a leg rises
- Ergonomic design

Key collaborating researchers:

Dr. Ou Ma, Mechanical and Aerospace Engineering Department

Dr. Jennifer Fabre, Human Performance, Dance and Recreation Department

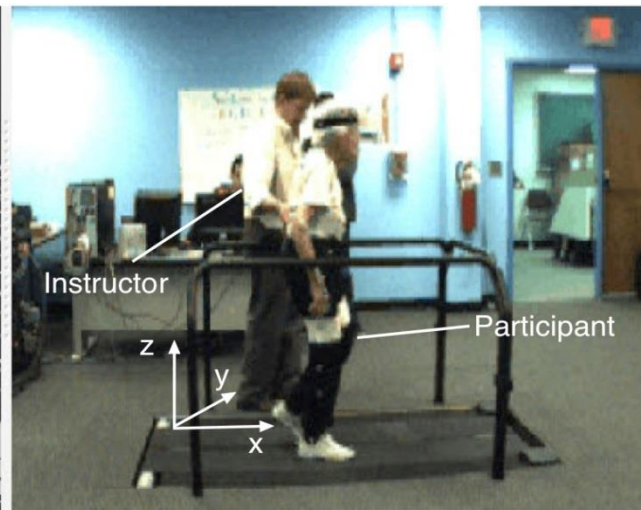
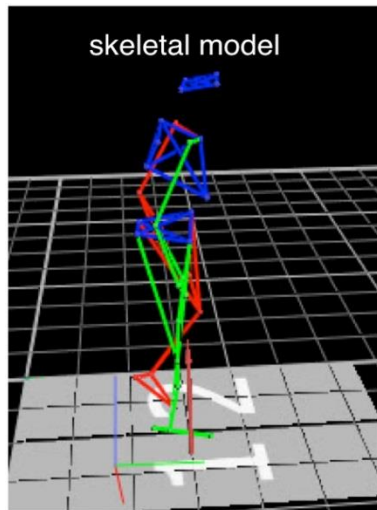
Prediction and Prevention of Fall Risk of Old Adults

We are studying a new measurement index called *mobility index* to measure the risk of falls and to assess the progress of falls prevention measures. The index was derived based on the understanding of human walking dynamics.

Result of a pilot study

Table 1. Values of μ measured from walking of older participants

Subject #	Fallers	Non-fallers
1	15.2	19.1
2	13.5	24.3
3	13.3	24.7
4	17.1	16.5
5	15.6	13.2
6	11.3	35.0
7	12.2	23.6
8	9.3	16.7
9	16.9	29.2
10	20.8	19.2
11	15.9	16.9
Average	14.6 ± 3.2	21.7 ± 6.4
p-value	0.0073	



Key researchers in the team:

Dr. Robert Wood, Human Performance, Dance and Recreation Department

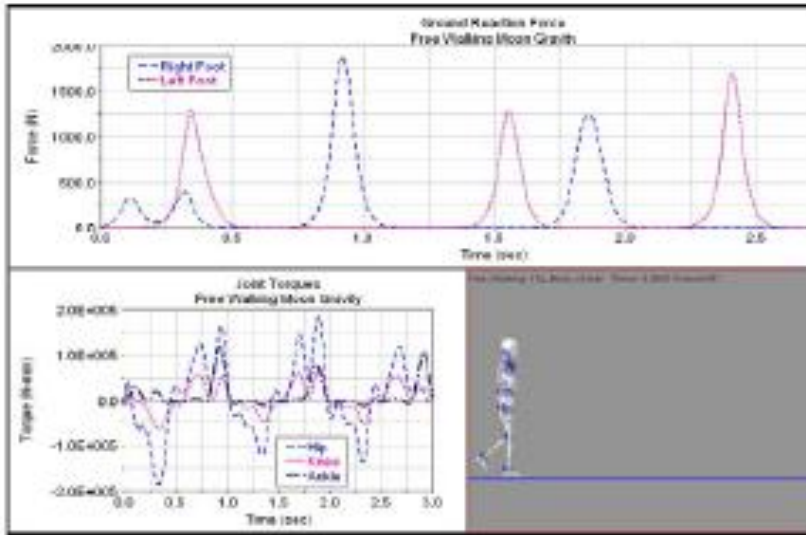
Dr. Ou Ma, Mechanical and Aerospace Engineering Department

Dr. Jennifer Fabre, Human Performance, Dance and Recreation Department

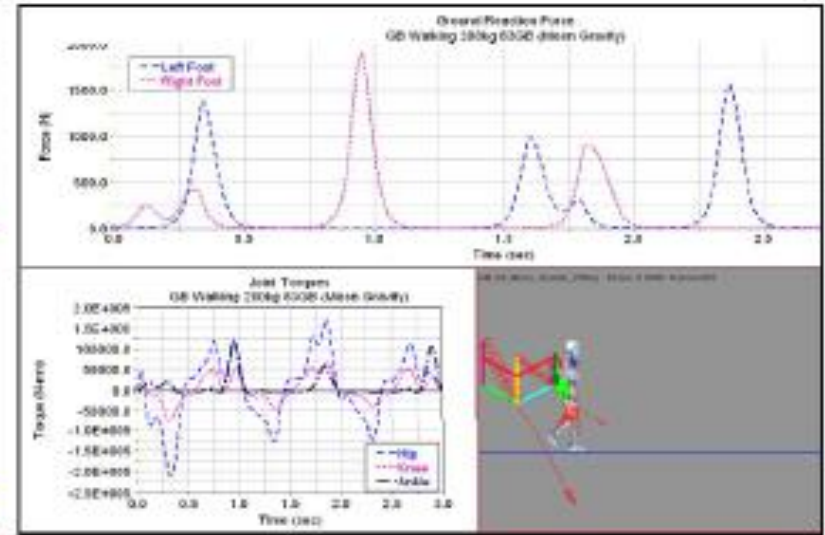
[Video](#)

Mathematical Modeling and Simulation of Human Bodies

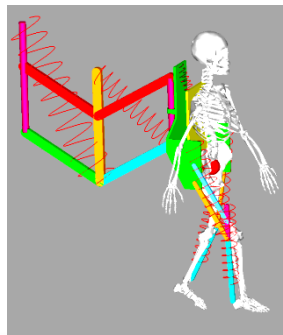
Model a human body as a multi-body system for dynamically simulating and analyzing human physical behavior



Walking on the Moon



Simulate walking on the moon using our RGB system

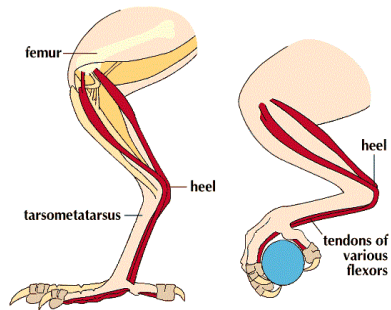


Key collaborating researchers:

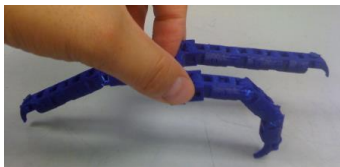
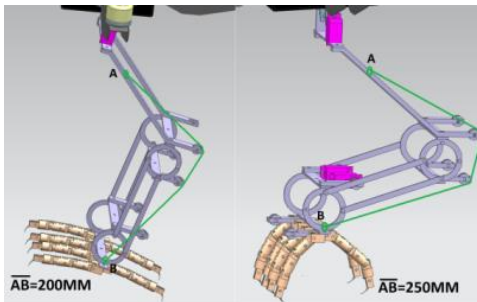
Dr. Ou Ma, Mechanical and Aerospace Engineering Department

Dr. Tonghui Wang, Mathematics Department

Bio-Inspired UAV Design, Guidance and Control



Inspiring



Robotic foot for UAV made by 3D printing

Nature has been optimized over millions of years and thus, we want to learn from the nature for design innovation

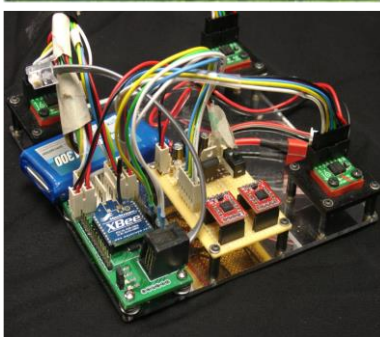


Key collaborating researchers:

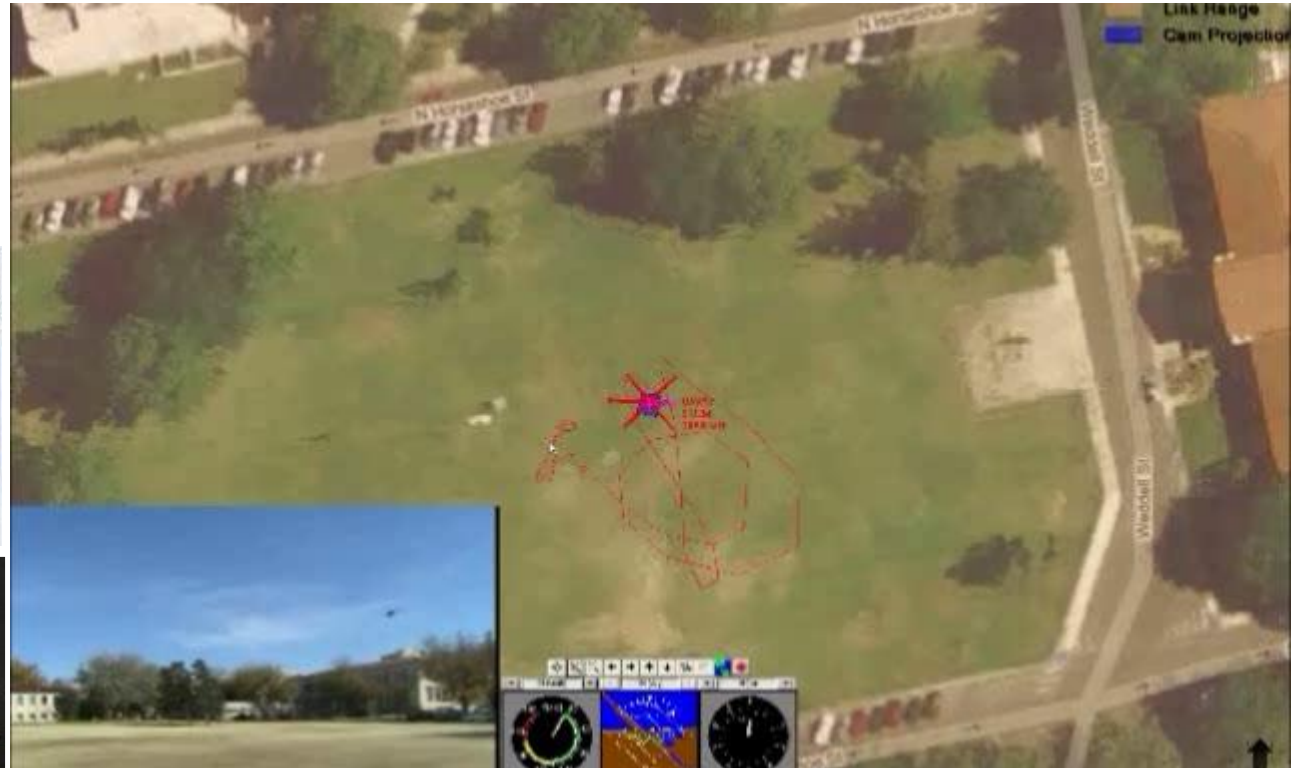
Dr. Ou Ma and Ken Ruble, Mechanical and Aerospace Engineering Department

UAS Autopilot System Integration and Testing

We turned a low-cost RC toy helicopter into an autonomous UAV



Student designed IMU



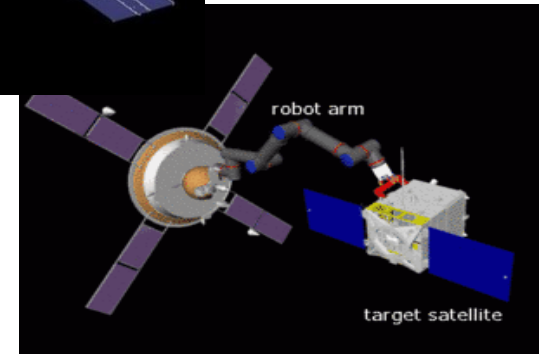
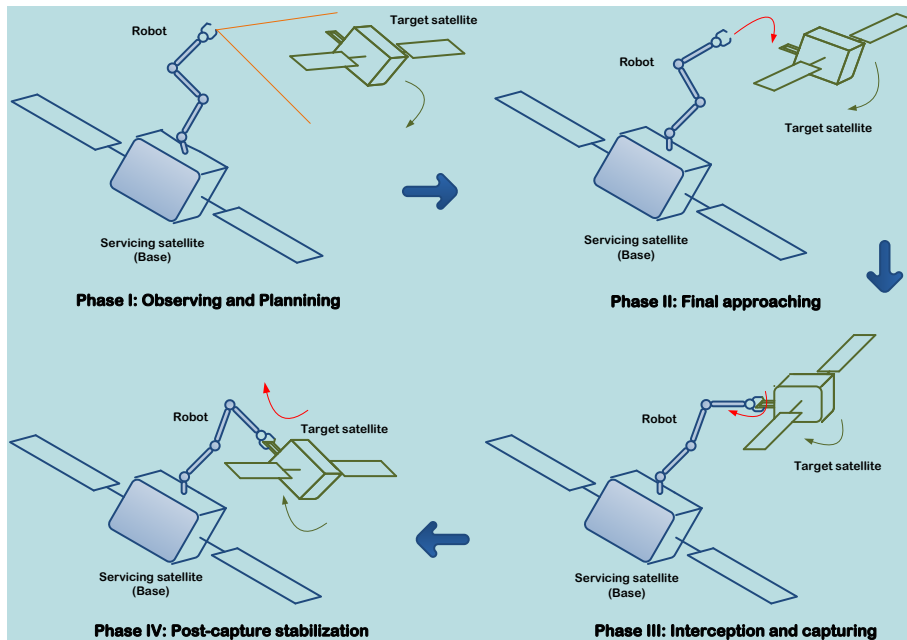
Key collaborating researchers:

Dr. Ou Ma and Ken Ruble, Mechanical and Aerospace Engineering Department

[Video](#)

Space Robotics Control for On-Orbit Servicing

- Tracking and capturing a satellite in orbit for service by a robot is a difficult task
- Capturing a tumbling object in orbit is even more challenging and risky job
- More advanced robotic technology needs to be developed



Key researcher:

Dr. Ou Ma, Mechanical and Aerospace Engineering Department

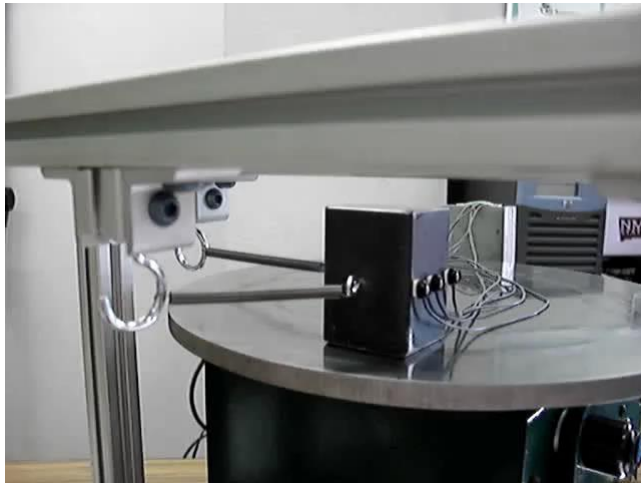
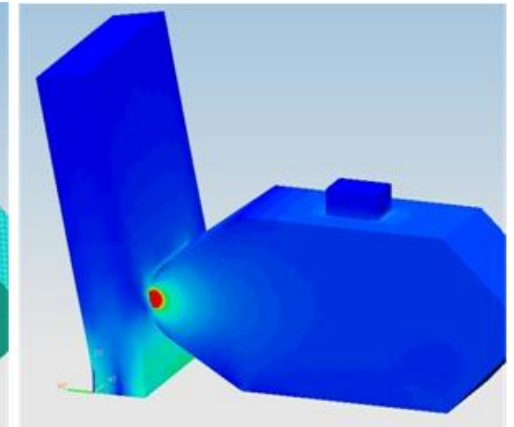
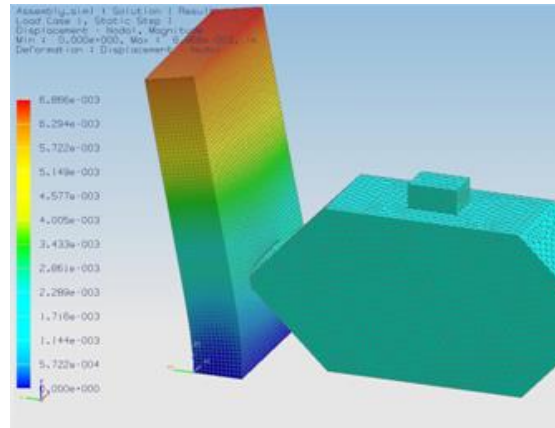
Impact-Contact Dynamics Modeling and Simulation

Goals:

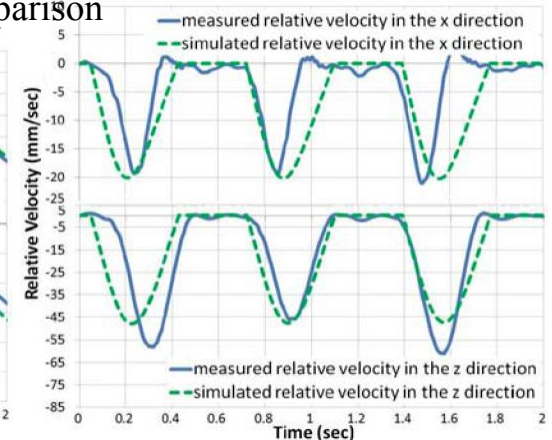
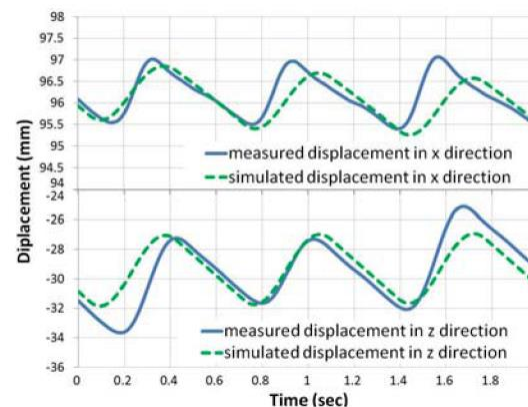
- Enhances technology for [simulating complex systems](#).
- Improves the efficiency and quality of impact-contact dynamics simulations

Methods:

- Model order reduction
- Systematic identification of the key model parameters (i.e., stiffness, friction, damping parameters)



2D stick-slip test/simulation comparison



Key researcher:

Dr. Ou Ma, Mechanical and Aerospace Engineering Department

[Video1](#)

[Video2](#)